Osteoarthritis of the Thumb Carpometacarpal Joint in Women and Occupational Risk Factors: A Case–Control Study

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Purpose: Among other etiologic factors involved in first carpometacarpal (CMC) osteoarthritis (OA), occupational factors have been postulated as influencing the occurrence of this condition. Very few epidemiologic studies, however, have evaluated this topic. Determining the occupational risk factors is important in proposing preventive measures at the workplace. This case–control study was undertaken to explore whether there was a history of greater exposure to some occupational factors (eg, occupations, hand postures, tasks involving the CMC joint) in women requiring surgery for CMC OA compared with women with no CMC OA noted by history and physical examination.

Methods: The case subjects were 61 women surgically treated for primary CMC OA and the control subjects were 120 aged matched women without history or features of CMC OA. A detailed structured interview was developed to elicit information about age, smoking habits, medical history, lifestyle history, and occupational factors. Occupational factors were based on a detailed history of jobs, coded according to the International Standard Classification of Occupations. For the main occupation/job held for the longest duration and during an average working day, subjects were asked about hand posture or tasks involving requirements presumed to cause a strain or a high load to the CMC joint and about certain work conditions.

Results: Of the 61 case and 120 control subjects, 5 and 14, respectively, had never worked. There was no difference between the average number of jobs through the working lifetime of the group of case subjects compared with the group of control subjects. Logistic regression analysis showed that after adjustment for age, smoking status, obesity, CMC OA family history, hysterectomy history, parity, and occasional job, the following occupational factors were risk factors for CMC OA: occupations presumed to be associated with increased risk for CMC OA, occupations involving repetitive thumb use, and jobs perceived by the subject having not enough rest breaks during a day. The group of case subjects had a higher prevalence of hysterectomy history and family CMC OA history compared with the group of control subjects.

Conclusions: Although previous studies have reported that work and exposure history may lack precision as risk factors, our results give further evidence to support the role of certain occupational factors in the occurrence of CMC OA in women. (J Hand Surg 2007;32A: 459–465. Copyright © 2007 by the American Society for Surgery of the Hand.)

Type of study/level of evidence: Therapeutic II.

Key words: Thumb, osteoarthritis, carpometacarpal joint, risk factors, occupation.
clear. Many risk factors have been suggested, including (1) inherent factors such as advanced age, female gender, congenital joint malformation, and genetic predisposition; and (2) acquired or environmental factors such as medical conditions, acute trauma, or long-term low-level stress. Among environmental factors, the role of occupational factors remains an open question. A relationship between CMC OA and specific occupations has been reported, but very few epidemiologic studies on the occupational factors associated with CMC OA have been performed.

Further research is required to better define the relationship between occupational factors and CMC OA. A better identification of occupational factors could lead to preventive measures at the workplace, which might reduce the prevalence of this condition.

The purpose of this case-control study was to explore whether there was a history of greater exposure to some occupational factors (eg, occupations, hand postures, tasks involving the CMC joint) in women requiring surgery for CMC OA compared with women with no CMC OA noted by history and physical examination.

Materials and Methods
Study Populations
This study was conducted in 2 separate institutions: in a center of hand surgery (La Chataîgneraie Medical Center, Beaumont, France) for case subjects and in a department of orthopedic surgery (University Hospital, Clermont-Ferrand, France) for control subjects. These 2 institutions are located in the same urban area, and case and control subjects were drawn from the same district area.

The case subjects were 61 white women who were surgically treated for advanced primary CMC OA in a specialty hand surgery center.

Control subjects were matched by ethnicity and 5-year age interval and were consecutively recruited in a department of orthopedic surgery. They were admitted overnight to the orthopedic surgery department (University Hospital, Clermont-Ferrand, France) for injuries or traumas secondary to motor vehicle collision or fall. None of the control subjects had a history or showed features of CMC OA. On examination of their thumbs, we asked about or examined for decreased range of motion, pain at rest or with use, painful grind test, CMC joint enlargement, subluxation and adduction deformity of the CMC joint, metacarpophalangeal joint hyperextension, and Heberden’s and Bouchard’s nodes. Excluded were patients mentally unable to comply with the administered questionnaire. Thus, 120 women were consecutively recruited into the control group.

All case and control subjects agreed to written informed consent to participate in this study.

Data Collection
A detailed structured interview was developed to elicit information about age, smoking habits, medical history, lifestyle history (sports, especially sports involving risks for the thumb such as golf and volleyball; leisure activities such as home improvement, domestic work), and occupational factors.

Medical history data were collected for the case subjects up to the date of the first diagnosis with special emphasis on factors known or supposed to contribute to the development of hand OA or CMC OA, assessed as yes/no, such as family history of CMC OA or at least one relative with CMC OA, thumb trauma history, diabetes mellitus, hypothyroidism, menopause, hysterectomy, parity, estrogen use, and use of oral contraceptives.

Weight and height were measured to calculate body mass index as weight (kg)/height (m)².

We asked about all occupations held for at least 6 months since leaving school. For the main occupation/job held for the longest duration (for case subjects up to the date of the diagnosis) and for an average working day, case and control subjects were asked about the following, assessed as yes/no:

- Hand posture or tasks involving requirements presumed to cause a strain or a high load on the CMC joint such as repetitive thumb use (>20 movements per minute and/or thumb flexion–extension at least once per minute), fine or strong pinch actions (tip, lateral, or palmar pinch); gripping/grasping; and pressure on the pad of the thumb. Visual aids were used to facilitate case and control subjects’ memories.
- Work conditions such as whole body vibration, working with a hand-held vibrating tool, working with gloves, exposure to cold, and perceived adverse psychosocial or organizational conditions at work.

These items were selected because they had previously been identified as risk factors for hand OA or CMC OA.

All case and control subjects were interviewed face to face by the same interviewer using a detailed structured and standardized interview.
Data Analysis
We focused our analysis on occupational factors: type of occupation, hand posture, or tasks presumed to cause a strain or a high load on the CMC joint and subject perceptions of work conditions.

For analysis, the types of occupation described by subjects were coded according to the International Standard Classification of Occupations (ISCO-88) of the International Labour Office (4-digit codes). The coders were unaware of the specific hypotheses. The conceptual approach adopted for ISCO-88 resulted in a pyramid that consists of 10 major groups at the top level of aggregation (1-digit level), which subdivided into 28 submajors (2-digit level), 116 minor groups (3-digit level), and 390 unit groups (4-digit level).

For case subjects, only the longest held occupation before treatment was considered for the analysis of occupations.

For this analysis, we first distinguished 2 groups: manual occupations, including occupations whose main tasks require the use of hands (Table 1), and nonmanual occupations.

We distinguished 2 other groups: occupations assumed as “being at risk for CMC OA,” including occupations for which the main tasks require thumb use (Table 2), and occupations not at risk. This classification was based on published literature or on our personal opinions.

There were many potential confounding nonoccupational factors. Thus, we first compared the mean (±SD) prevalence of nonoccupational factors between case and control subjects, using the chi-square test, Fisher exact test, and Student t test. The selection of nonoccupational factors for adjustment was based on: (1) recognized risk factors for CMC OA for which there was a significant difference between the 2 studied groups, such as age, parity, hysterectomy history, family CMC OA

Table 1. ISCO-88* Group Titles Defined as “Manual Occupations” for Data Analysis

<table>
<thead>
<tr>
<th>ISCO-88 Unit Groups</th>
<th>ISCO-88 Minor Groups</th>
<th>ISCO-88 Major Groups</th>
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<tbody>
<tr>
<td>2222–Dentists</td>
<td>213–Computing</td>
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<tr>
<td>2230–Nursing</td>
<td>213–Computing</td>
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<td>2451–Authors,</td>
<td>312–Computer</td>
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<td>2452–Sculptors,</td>
<td>411–Secretaries</td>
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<td>3231–Nursing</td>
<td>412–Numerical</td>
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<tr>
<td>3226–Physiotherapists and related associate professionals</td>
<td>413–Material-recording and transport clerks</td>
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<tr>
<td>4144–Scribes and related workers</td>
<td>414–Library, mail, and related clerks</td>
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<tr>
<td>4211–Cashiers and ticket clerks</td>
<td>419–Other office clerks</td>
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<tr>
<td>4212–Tellers and other counter clerks</td>
<td>513–Personal care and related workers</td>
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<tr>
<td>5122–Cooks</td>
<td>ISCO-88 Minor Groups</td>
<td></td>
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<tr>
<td>5123–Waiters,</td>
<td>6–Skilled agricultural</td>
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<tr>
<td>5141–Hairdressers,</td>
<td>7–Craft and related</td>
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<td>5142–Companions</td>
<td>8–Plant and machine</td>
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<td>5152–Fortune tellers</td>
<td>9–Elementary occupations</td>
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<td>valets</td>
<td>operators and assemblers</td>
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<td></td>
<td>9–Elementary occupations</td>
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*ISCO-88: International Standard Classification of Occupations of the International Labour Office

Table 2. ISCO-88* Group Titles Assumed as “Being at Risk for CMC OA” for Data Analysis

<table>
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*ISCO-88: International Standard Classification of Occupations of the International Labour Office
history, and occasional jobs; and (2) factors that have been used in common analytic models used in the literature, such as obesity and smoking status.

Relative risks for occupational factors were then estimated using odds ratios (ORs) and 95% confidence intervals (CIs) from a logistic regression model adjusted for nonoccupational factors.

A p value less than .05 or a 95% CI not including the null point were regarded as statistically significant.

Statistical analyses were performed using software (PC SAS; SAS Institute, Inc., Cary, NC).

**Results**

We observed differences among some of the nonoccupational factors known or supposed to contribute to hand OA or CMC OA.

The case subjects were slightly older than the control subjects (64 ± 9 y vs 60 ± 10 y, p = .01). The case subjects had more live children than control subjects (2.32 ± 1.40 vs 1.91 ± 1.53 children, p = .04). The case subjects had a higher prevalence of hysterectomy compared with control subjects (19/61 vs 17/120, p = .007). Ten of 61 case subjects gave a family history of CMC OA compared with 6 of 120 control subjects (p = .01). The mean number of self-reported cumulative years of occasional jobs in case subjects was significantly higher than in control subjects (8 ± 16 y vs 3 ± 8 y, p = .02).

None of the other studied nonoccupational characteristics were statistically different between the 2 groups.

Of 61 case and 120 control subjects, 5 and 14 subjects, respectively, had never worked.

There was no difference between the average numbers of jobs (held for at least 6 mo) through the working lifetime of the case subjects compared with the control subjects (1.50 ± 1.22 vs 1.30 ± 0.94, respectively).

After adjustment for age, smoking status, obesity, CMC OA family history, hysterectomy history, parity, and occasional jobs, the following occupational factors were significantly associated with an increased risk of CMC OA:

- Occupations presumed being at risk for CMC OA: OR = 3.78 (95% CI, 1.20–11.92) (24/56 case subjects, 29/106 control subjects). The occupations observed, indicated by ISCO-88 code, were mainly 4115–secretaries; 7433–tailors, dressmakers, and hatters; 7436–sewers, embroiderers, and related workers; and 9131–domestic helpers and cleaners.
- Repetitive thumb use: OR = 11.91 (95% CI, 3.65–38.86) (26/56 case subjects, 10/106 control subjects).
- Jobs perceived by subjects as having “Not enough rest breaks during a day”: OR = 5.95 (95% CI, 1.66–21.28) (50/56 case subjects, 70/106 control subjects).

After adjustment for the nonoccupational factors, no significant association was observed between CMC OA and the other studied occupational factors, especially with regard to “general manual occupation,” “fine or strong pinch actions,” “gripping/grasping,” “pressure on the pad of thumb,” whole body vibration, working with a handheld vibrating tool, working with gloves, exposure to cold, and perceived adverse psychosocial or organizational conditions at work, except “not enough rest breaks during a day.”

**Discussion**

The significant findings of this study were that repetitive thumb use in active life (and without enough rest breaks during a working day) and occupations for which the thumb load is greater than would normally occur were associated with a higher risk of CMC OA. Thus, our findings reinforce previous findings regarding the positive association between occupations involving repetitive or prolonged thumb overuse and CMC OA. Lawrence showed that radiologic evidence of OA was more frequent in CMC joints in men employed in a cotton spinning mill, who used their fingers continuously and rapidly, than in control subjects. Hadler et al observed female textile workers who performed nonforceful and repetitive manual tasks and found an influence of usage patterns on the structure and function of the hands. In a case-control study, Ferreiro Seoane et al showed that a typical pattern of hand OA, including CMC OA, was associated with prolonged manual milking (>20 y), with most patients being women. In a case-control study, Elsner and observed that the risk of CMC OA in women was elevated for typists and for work involving dexterity.

In contrast, an association between CMC OA with a specific thumb task, function, or position presumed involved in the pathogenesis of CMC OA was not apparent in the present study, despite previously published hypotheses. As mentioned earlier, we observed a higher risk only for some occupations for which hand posture or task requirements were presumed to cause a strain on the CMC joint (eg, tailors, dressmakers, and hatters; sewers, embroiderers). The control group of the study undertaken by Lawrence
included about 30% coal miners. According to Lawrence, this emphasizes the importance of specific hand tasks (cotton spinning) as opposed to general heavy tasks (coal mining) in the development of hand OA. Some hand positions such as tip, lateral, or palmar forceful pinch might cause high pressure patterns in the CMC joint. According to a biomechanic analysis, the joint compression (contact) forces average 3 kg of force at the interphalangeal joint, 5.4 kg at the metacarpophalangeal joint, and 12 kg at CMC joint during a simple pinch (1 kg of applied force). Compression forces of as much as 120 kg, however, may also occur at the CMC joint during strong grasp. Finally, some investigators have shown that cartilage wear occurs on the volar–ulnar and dorsal–radial quadrants of the CMC joint when the trapezium and metacarpal are placed in an incongruous position caused by specific positions such as lateral pinch and flexion–adduction.

Previous results and ours suggest that the occupational factor risk of CMC OA relates to: (1) specific thumb motions and to the frequency and duration with which those thumb motions are performed, and (2) specific thumb positions and to the magnitude of forces generated by these thumb positions. These combinations may constitute long-term mechanical stresses, resulting in degenerative changes in the articular cartilage and initiating CMC OA. Previous contact area studies provide supporting evidence to the theory that abnormally high stresses may initiate or exacerbate OA progression in articular cartilage.

Exposure to mechanical stress alone, however, is insufficient to explain fully the development of CMC OA. Other different contributing factors are also involved, such as genetic factors and female gender. Spector et al provide clear evidence of a genetic effect on OA in women independent of known environmental factors. Jonsson et al showed a familial factor in all subsets of hand OA among an Icelandic population, in particular in the thumb CMC joint. Furthermore, their results suggested that the familial factor is genetic and that the genetic influence increased with increasing severity of the disease. Because surgical treatment has been indicated, our case subjects may be classified as having severe disease. This might explain the significant relationship in our study between a positive family history of CMC OA and the outcomes of the disease. By comparing self-reports with worksite measurement performed 6 years earlier. Higher reproducibility among women was found for the question items on repetitive finger movements. Sufficient reproducibility was found for 3 items on the manual handling of loads, especially among men.

To our knowledge, no relevant valid job-exposure matrix exists to classify the jobs according to the level of physical work load and strain on thumbs. For these reasons, we used the only available evaluation control study. They compared women who had had a hysterectomy with those who had not and found an increased risk of CMC OA apart from knee OA, supporting an estrogen hypothesis. Our data also showed that the case subjects had a higher rate of women with hysterectomies than the control subjects. For Kessler et al, however, this is not a valid explanation for the isolated effect on only one joint group in the hand.

Anatomic factors might be another explanation. It was determined that male CMC joints are considerably more congruent than female joints because of the different shape of the trapezial surfaces and size difference in the joints of the 2 genders. Consequently, contact stresses in female CMC joints are greater than those in male joints in similar joint-loading conditions. Thus, during activities involving pinch or grasp, female thumb CMC joints may experience higher stress than male joints.

This study has certain limitations with regard to (1) the retrospective evaluation of work-related past exposures and (2) the possibility of differential recall bias between case and control subjects.

Case-control studies typically attempt to obtain exposure information retrospectively without the benefit of reliable records. Relatively few published studies have investigated the accuracy of retrospective assessments of past physical activities or loads by questionnaire, and none of these has addressed thumb activities. Köster et al compared self-reported information on the same physical and psychosocial exposures over a subsequent period of 24 years. Acceptable—although not high—agreement was found for, among other things, 3 physical factors: heavy lifting, physically demanding work, and daily vigorous physical exertion. The researchers concluded that the influence of the misclassification on the risk estimates was limited. Torgén et al evaluated questionnaire-based information on past physical work loads by comparing previous questionnaire responses on current work loads with responses to the same items obtained 6 years later. Validity was assessed by comparing self-reports with worksite measurement performed 6 years earlier. Higher reproducibility among women was found for the question items on repetitive finger movements. Sufficient reproducibility was found for 3 items on the manual handling of loads, especially among men.

To our knowledge, no relevant valid job-exposure matrix exists to classify the jobs according to the level of physical work load and strain on thumbs. For these reasons, we used the only available evaluation
of work-related exposures based on job titles, especially jobs involving frequent tasks with thumbs, and on specific questions about whether subjects had ever performed hand activities presumed to cause a high load/strain on the CMC joint.

In case-control studies, case subjects are suspected of responding to the retrospective questionnaire in the affirmative more often than control subjects because they might more accurately report or overreport exposures, leading to an overestimation of potential occupational risk factors. Conclusions from studies dealing with musculoskeletal disorders or rheumatologic disease about recall of occupational exposure, however, are not uniform. Köster et al compared information on the same physical work exposures with 25 years’ difference for people with and without neck or shoulder symptoms. No apparent differences in assessments were found. They observed minor differences about recall of exposure between subjects with and without low-back disorders; however, this did not substantially influence the estimation of relative risk. In a study conducted by Wiktorin et al, musculoskeletal complaints seemed to cause differential bias in self-reported exposures to lifting but not to postures. Finally, in the study of Torgén et al, misclassification of exposure did not appear to be differential with regard to musculoskeletal symptom status, as judged by the calculated risk estimates. We therefore purposely kept a simple and qualitative (ever/never) assessment of work-related thumb postures and movements to make this recall more accurate for both case and control subjects.

Although our data support the view that occupational factors are presumed to play a role in the occurrence of CMC OA, this condition is probably of complex multifactorial origin, with mechanical stress only one among many factors that interact in determining CMC OA. Moreover, interactions between constitution and environment such as changes of lifestyle (eg, in work life) and in predisposed people (eg, women, those with genetic predisposition) may have a strong effect. Further studies are required to characterize the interplay between constitutional and mechanical factors in the pathogenesis of this condition. Nevertheless, ergonomic solutions to CMC OA problems are necessary to decrease thumb motions or strenuous effort in general encountered at work, especially for women.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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References


Received for publication July 3, 2006; accepted in revised form January 19, 2007.

The authors would like to thank Professor S. Terver and Professor S. Boigard for their assistance in recruiting control subjects.


